IS 7146-1 (1973): Methods of measurement on photosensitive devices, Part 1: Basic considerations [LITD 4: Electron Tubes and Display Devices]

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Indian Standard

METHODS OF MEASUREMENTS ON PHOTOSENSITIVE DEVICES

PART I BASIC CONSIDERATIONS

UDC 621·383 : 535·247·4

INDIAN STANDARDS INSTITUTION
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110001

April 1974

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TO
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PART I BASIC CONSIDERATIONS

Corrigendum

(*Page* 5, *Fig.* 1) — Delete the word ' PISTE '.

(ETDC 40)

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Indian Standard
METHODS OF MEASUREMENTS ON PHOTOSENSITIVE DEVICES
PART I BASIC CONSIDERATIONS

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Indian Standard
METHODS OF MEASUREMENTS ON PHOTOSENSITIVE DEVICES
PART I BASIC CONSIDERATIONS

0. FOREWORD

0.1 This Indian Standard (Part I) was adopted by the Indian Standards Institution on 29 November 1973, after the draft finalized by the Electron Tubes Sectional Committee had been approved by the Electrotechnical Division Council.

0.2 This standard is largely based on IEC Pub 306-1(1969) ' Measurement of photosensitive devices, Part 1 Basic considerations ' issued by the International Electrotechnical Commission.

0.3 This standard is one of a series of Indian Standards on special purpose electron tubes. A list of standards so far prepared in this series is given on the fourth cover page.

0.4 For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test, shall be rounded off in accordance with IS : 2-1960*. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

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1. SCOPE

1.1 This standard (Part I) covers basic considerations relating to general measuring methods applicable to all types of photosensitive devices.

2. TERMINOLOGY

2.0 For the purpose of this standard the terms and definitions prescribed in IS : 1885 (Part IV/Sec 8)-1973† shall apply.

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*Rules for rounding off numerical values (*revised*).

†Electrotechnical vocabulary: Part IV Electron tubes, Section 8 Photosensitive devices.

3. GENERAL CONDITIONS

3.1 Basically, the properties of a photosensitive device are measured by exposing it to a calibrated radiation source.

3.1.1 Between the source and the device being measured, there shall be a blackened screen of sufficient size which supports a shutter, usually it is located near the source.

3.1.2 Behind the source, at a distance of about 1 m, there shall be a blackened background in order to avoid reflected radiation.

3.1.3 Between the shutter and the device being measured, a series of blackened baffles shall prevent stray radiation falling on the device. The baffles should be designed with sharp edges in order to avoid series reflections.

3.1.4 If additional walls are used to close completely the space between the shutter and the device, precautions shall be taken that they are well blackened and that there are no disturbing inter-reflections.

3.2 As all sources develop heat, and the emitted radiation in practically all cases depends on the temperature of the source, closure of the space between the screen and the background should be avoided. A rise in temperature of the background caused by the source is only important if very long wavelengths are to be measured. This effect can be taken into account by a reading without the source, immediately after the radiation measurement. It should also be checked, with the source so far removed that no direct radiation falls on the device, whether there is any effect from radiation reflected by the background or not; this includes radiation from other sources in the room.

3.3 The device should be so oriented that the radiation beam falls perpendicularly on the photosensitive surface, and a baffle immediately in front should be chosen so as to expose only the specified area of this surface. Filters or other attenuating devices may be located at a suitable place between the shutter and the device.

3.4 The optical axis of the radiant flux usually passes through the centre of the photosensitive surface, so that the track on which the radiation source may move will be parallel to this optical axis.

3.5 If the distance between source and device has to be altered in order to obtain another value of irradiation, it is advisable, for measurements, to move the device and not the source. For measurement of lower accuracy, of course, the source may also be moved.

3.6 Light-proof Enclosure — These general conditions specified in **3.1** to **3.5** may be realized by a light-proof enclosure. In practice, the

enclosure is usually divided into two sections, one for the device being measured and the other for the light source, with specified apertures and filters inserted at the dividing partition. The distance between the light source and the device being measured may be variable (*see* Fig. 1).

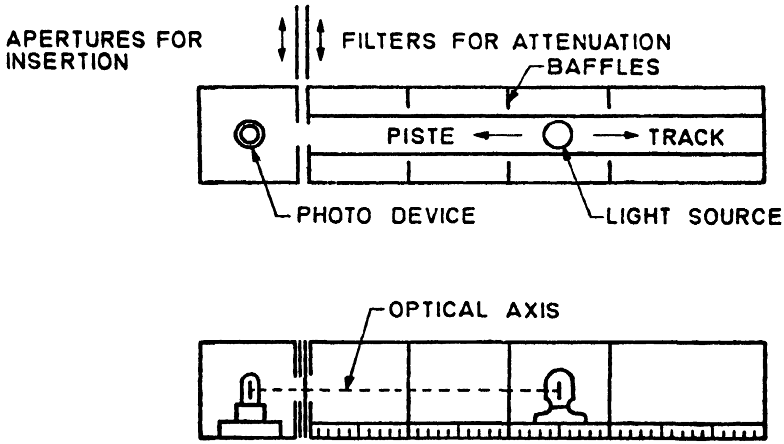

FIG. 1 EXAMPLE OF LIGHT-PROOF ENCLOSURE WITH FIXED PHOTOSENSITIVE DEVICE AND MOVABLE LIGHT SOURCE

4. MEASURING ELEMENTS

4.1 Standard Radiation Source — For the purpose of this standard, only standard illuminant A is considered [*see* **4.17** of IS : 1885 (Part IV/ Sec 8)-1973*].

NOTE 1 — In order to improve the life and the stability during life of the radiation source a lower colour temperature, for example 2 700°K, may be used; however, the lower colour temperature will introduce errors because of variations in spectral sensitivity, even between devices of the same type.

For reference measurements, a colour temperature of 2 854°K shall be used.

NOTE 2 — Tungsten filament lamps are extremely sensitive to variations in applied current. A 1-percent change in current causes a 7-percent change in light intensity and a 15 to 20°K change in colour temperature.

4.2 Radiation Sources for Measurement

a) *Light Sources* — Either a secondary standard light source or a tungsten filament lamp calibrated according to **4.3** should be used as the light source for measurements of the photosensitive devices.

*Electrotechnical vocabulary: Part IV Electron tubes, Section 8 Photosensitive devices.

b) *Ultra Violet Sources* — A commonly used source is a low-pressure mercury discharge lamp, with a specified envelope and filter, calibrated at 253·7 nm. There is also a high-pressure mercury discharge lamp of type UV-standard, the radiation of which at 366 nm is known.

NOTE — To avoid errors, reference is made to **4.5**.

c) *Infra-red Sources* — Under consideration.

4.3 Calibration of Radiation Sources — The radiation source should be calibrated by the following method:

a) The secondary standard should be certified periodically by an authorized laboratory,

b) The working standard used for measurements should be calibrated by an approved means against the secondary standard light source, and

c) The distance between the working standard and the photosensitive surface should be established with a suitable light sensitive device so that the working standard gives the same luminous flux as the secondary standard lamp does at the photosensitive surface.

4.4 Intensity Measurement Equipment — For comparison purposes, in checking the working standard against the secondary standard, an intensity measuring device is needed; examples are: MacBeth Illuminator, Lummer-Brodhun-Photometer, stable phototubes or photovoltaic cells or other photosensitive devices corrected to standard colorimetric observer.

4.5 Spectral Measurement Equipment

4.5.1 The required apparatus for measuring the spectral sensitivity includes a source of monochromatic radiation at various wavelengths throughout the spectrum and a means of measuring the radiant power incident on the photosensitive device.

4.5.2 The degree of spectral purity required is dependent on the rate of change of spectral sensitivity as a function of wavelength.

4.5.3 Normally spectral bandwidths of the order of 1 percent of the wavelengths concerned are sufficiently narrow. Precautions shall be taken to ensure that extraneous radiation does not reach the device being measured.

4.5.4 A monochromator, such as the double prism or double-pass variety, may be used to provide high spectral purity. Even with these instruments, filters may be required to eliminate scattered radiation at wavelengths where the source emits strongly, or where the device being measured has very high sensitivity. The primary radiation source will depend on the

wavelength desired. In the ultraviolet range, a mercury, xenon or hydrogen discharge lamp is generally used. For the visible and near-infra-red range, the tungsten incandescent lamp is satisfactory.

4.5.5 A calibrated blackened-target thermocouple or thermopile plus the associated measuring circuitry is generally used for the measurement of the exit radiant power from the monochromator. In some instruments, the thermocouple is an integral part of the monochromator, with provision for shifting the beam of radiant energy emerging from the exit slit either to the thermocouple or through an exit window on the photosensitive surface.

NOTE — Care should be taken to avoid inaccuracies due to the thermocouple drift and change in the photosensitive device dark current. One method of achieving this is to include a light chopper in the monochromator, so that the output of the thermocouple or the photosensitive device can be measured using a tuned amplifier or a synchronous detector.

4.5.6 For ordinary use, a set of filters with known characteristics in conjunction with a suitable light source may be used for the measurement of spectral sensitivity.

4.6 Sensitivity Measurement Equipment

4.6.1 *Attenuating Filters* — Because the range of measurement which can be obtained by moving the lamp, the full length of the enclosure, is typically only about 10 to 1, a series of attenuating filters of known characteristics is needed, or some equivalent thereof.

5. MEASUREMENTS

5.1 Illuminance and Irradiance — If a working standard is calibrated for luminous intensity in a certain direction, the illuminance on the photosensitive surface, which has to be perpendicular to this direction, may be calculated as follows:

$$E_v = \frac{I_v}{d^2}\Omega_0$$

where

E_v = illuminance in lux,

I_v = luminous intensity of the light source in the direction concerned in candelas,

d = distance in metres, and

Ω_0 = 1 steradian.

The same relation holds for irradiance E_e and radiant intensity I_e:

$$E_e = \frac{I_e}{d^2}\Omega_0$$

5.2 Luminous Flux and Radiant Flux — The luminous flux may be derived from the illuminance as follows:

$$\phi_V = A \times E_V$$

where

ϕ_V = luminous flux in lumens,

A = area of the photosensitive surface in square metres, and

E_V = illuminance in lux.

The same relation holds for radiant flux ϕ_e and irradiance E_e :

$$\phi_e = A \times E_e$$

INDIAN STANDARDS

ON

SPECIAL PURPOSE ELECTRON TUBES

IS:

1885 (Part IV/Sec 1)-1973 Electrotechnical vocabulary: Part IV Electron tubes, Section 1 Common terms (*first revision*)

1885 (Part IV/Sec 8)-1973 Electrotechnical vocabulary: Part IV Electron tubes, Section 8 Photosensitive devices

4697-1968 Method of measurements on Geiger-Müller counter tubes

5323-1969 Letter symbols and abbreviations for electron tubes

6576-1972 Methods of measurements on gas filled cold cathode indicator tubes

6577-1972 Methods of measurements on gas filled cold cathode voltage stabilizing and voltage reference tubes

7146 (Part I)-1973 Methods of measurements on photosensitive devices: Part I Basic considerations

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